



On the Air

Technical Notes on Important Air Quality Issues

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How Clean is The Air? Tennessee Valley Air Quality Trends

Science: Contrary to popular perception, air quality in the TVA region, with few exceptions, is substantially better today than it was when the first national clean air standards were adopted in 1971.

Policy: The air quality issues and management solutions of today are larger, more complex and more challenging than ever before. Many issues associated with primary pollutant emissions--such as suspended particles, sulfur dioxide and carbon monoxide--have been resolved. But, the tougher secondary pollutants (such as ozone and fine particles) and values related to air quality (such as visibility impairment, global climate change and acidic deposition) remain controversial and a challenge.

Introduction

In July 2003, TVA produced a 29-page report entitled, "How clean is the air? Air Quality in the Tennessee Valley Region." This report looks back on 24 years of air quality in the east-central United States, considering trends from 1979 through 2002. In addition to examining problems associated with federal clean air standard pollutants, the report considers acid rain, hazardous (i.e., toxic) air pollution, fine particulates, indoor air quality, visibility impairment, and global climate change.

Clean air "yardsticks"--National Ambient Air Quality Standards (NAAQS)--were established by the U.S. EPA in 1971, following the 1970 Clean Air Act Amendments. There are two kinds of NAAQS: (1) "Primary standards," which set air quality limits protective of public health, and (2) "Secondary standards," which set limits protecting public welfare, including animals, crops, vegetation, materials, and visibility.

Current NAAQS include six air pollutants (often referred to as "criteria pollutants"): particulate matter, sulfur dioxide, ozone, carbon monoxide, nitrogen dioxide, and lead. In order to keep these NAAQS standards current, the U.S. EPA periodically reviews and, if warranted, updates these standards to keep in step with new findings.

Criteria Pollutants

Sulfur Dioxide

Sulfur dioxide gas can be an upper respiratory irritant that also can injure vegetation, accelerate corrosion of building materials, produce fine particles, and contribute to acidic deposition and reduced visibility. Human-caused sources account for about 90 percent



of gaseous sulfur emissions in the U.S.

Regional SO₂ management strategies have been a clear success, leading to: (1) a reduction (improvement) of 50 to 60 percent in maximum air concentrations since 1979 (Figure 1); (2) the virtual elimination of NAAQS violations and of direct effects of SO₂ on health and vegetation; and (3) a 45 percent reduction in the sulfate concentration of precipitation. Despite these successes, concern remains about the contribution of SO₂ to the production of secondary fine particles. Since sulfur-containing particles make up a significant portion (30 to 60 percent) of fine particles in the eastern U.S., it is likely that additional SO₂ controls will be required to achieve the new fine particulate standards, to further reduce acid rain, and to meet visibility goals.

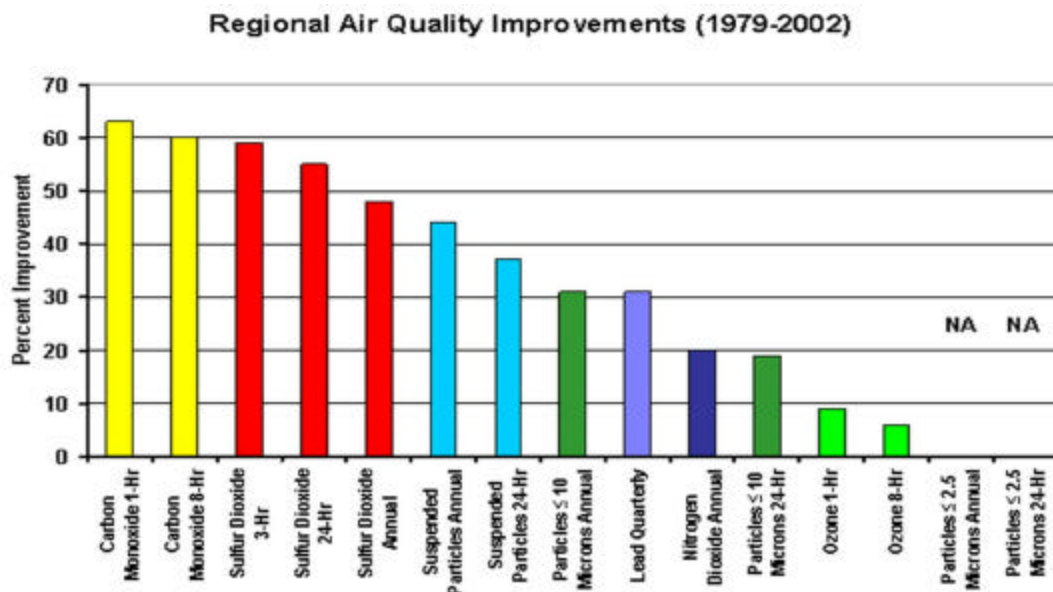


Figure 1. Percent improvement in Tennessee Valley Region air quality by pollutant.
Source: TVA, 2003. "How clean is the air? Air Quality in the Tennessee Valley Region."

Particulate Matter

Particulate matter (PM) consists of small solid "dust" particles or liquid droplets from a variety of natural and human sources. Fine particles (< 2.5 microns in diameter) are of greatest concern from both health and environmental perspectives. Fine particles contribute to the regional problems of acid rain, reduced visibility, and toxic air pollution. Human sources include agricultural activities, industrial processes, fossil-fuel combustion, transportation, construction, demolition, and mining.

In the east-central U.S., total suspended particulates have declined by more than 40 percent since 1979, and particulate matter less than 10 microns (PM₁₀) has declined by 30 percent since 1987 (Figure 1). Records to date are insufficient to establish trends for fine particles less than 2.5 microns in diameter (PM_{2.5}). However, fine particle air pollution will soon be the focus of additional reduction efforts, as new federal standards are implemented, and several areas in the region are expected to exceed the standards.

Ozone

While stratospheric ozone is "good," excess ozone in the lowest layer of the atmosphere, the troposphere, is considered "bad." In high concentrations, as sometimes found around large urban areas and at high elevations, ozone can cause respiratory problems, damage plants, and lower crop and forest productivity.

Ozone is formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight. Human sources of nitrogen oxide (NO_x) emissions are the most important contributors to excess ozone in the east-central U.S., with fossil fuel power plants, transportation sources, and "all other sources" each accounting for about one-third of the total. In the eastern

U.S., ongoing ozone management includes extensive NO_x reductions from large stationary sources such as fossil-fuel power plants, whereas future ozone management will focus on lowering NO_x emissions from a variety of sources. Ozone has been a challenge since 1979 when the first "How Clean is Our Air?" was published. There have been small but significant improvements in 1-hour ozone levels, but no significant change in 8-hour levels (Figure 1). Meeting the recently adopted 8-hour ozone standard will be a substantial challenge.

Nitrogen Dioxide

Regional nitrogen dioxide (NO₂) levels are well below the NAAQ standards, and there are no NO₂ non-attainment areas in the east-central U.S. Regional annual average NO₂ concentrations improved by about 20 percent from 1979 to 2002 (Figure 1). As discussed, nitrogen oxides figure prominently in ozone production, and are a major source of acidic deposition.

Carbon Monoxide

Outdoor carbon monoxide (CO) air pollution is an urban problem with highest levels occurring during heavy traffic in congested downtown urban "canyons" and tunnels. There has been a steady improvement in average CO levels throughout the last two decades. Average maximum 1- and 8-hour CO concentrations declined by 60 percent or more from 1979 through 2002 (Figure 1).

Lead

Twenty years ago the primary source of anthropogenic lead emissions was gasoline engine exhaust. Now, after a concerted effort to remove lead from gasoline, average concentrations are well below the level of the NAAQS. Overall, regional lead concentrations declined by about 30 percent between 1979 and 2002 (Figure 1).

Acidic Deposition

The principal human influence on acid deposition, more popularly referred to as "acid rain," is through the emission of strong-acid gases including sulfur dioxide, nitrogen oxides and hydrochloric acid, which eventually deposit through dry or wet deposition. Acid deposition has been associated with a number of adverse environmental effects including declines in fish, agricultural, and forest productivity; accelerated weathering and corrosion of building products; and adverse health effects. There is ongoing concern about the most sensitive ecosystems, high-elevation forests and streams.

With acid rain control strategies focused on lowering emissions of sulfur dioxide and nitrogen oxides, from 1979 through 2002, regional sulfate deposition declined (improved) by 33 percent and nitrate deposition by 4 percent. Additional improvements are expected as implementation of the acid rain control program established by the 1990 Clean Air Act Amendments continues.

Visibility Impairment

Some estimates suggest that average visibility in the east-central U.S. has declined by 60 percent over the past 50 years, with the worst visibility conditions occurring during late summer. Deterioration of visibility is linked to widely dispersed and intermixed pollutants from many sources, with most impairment due to fine sulfate and carbon particles.

In 1999, the U.S. EPA issued new regional haze regulations with a goal of restoring visibility in national parks and wilderness areas to "natural conditions" by 2064. The same management strategies developed to meet and maintain new fine particle standards should also contribute to improved visibility.

Toxic Air Pollution

Toxic air pollutants are a class of more than 650 chemicals which may potentially cause health

problems in a significant, but as yet "not precisely defined way." The sources of toxic air pollutants range from very large to very small industries. Persistent toxic pollutants, such as mercury, are of particular concern because of their global mobility and ability to accumulate in the food chain. More research is needed to understand the fate and effects of mercury and other toxic pollutants.

Indoor Air Quality

Partly because the average person spends more than 90 percent of his time inside home, office, or vehicles, poor indoor air quality can be a major health concern. Reduced ventilation, the existing burden of indoor pollution sources, and use of alternative heating sources can lead to significant indoor air pollution problems. The U.S. EPA, California Air Resources Board, and others suggest that typical indoor air pollution exposures are associated with much greater health risks than outdoor air pollution.

Global Climate Change

Much of the radiation from the sun is re-emitted from the earth and lost to space, but some is trapped by clouds and so-called "greenhouse gases." This trapped energy warms the atmosphere. Levels of one of the principal greenhouse gases, carbon dioxide, have increased by about 25 percent over the past century, largely due to fossil fuel combustion. Most global climate change models now suggest that global temperatures may rise an additional 1 to 2 degrees Celsius during the next 50 years. This could result in profound changes in the polar ice caps, sea level and rainfall patterns. Accelerated international research programs are needed to better understand global climate change and develop effective management strategies.

Conclusions

Implementation of clean air legislation has resulted in substantial emission reductions and in significant improvements in outdoor air quality. Outdoor air quality in the east-central U.S., in particular, and across the country in general, is much better today than 24 years ago. Levels of primary air pollutants have improved dramatically. Where once there were many clean air "non-attainment" areas, today there are few.

Ozone and fine particle pollution continue to be a major challenge with the promulgation of more stringent national standards. Certain air quality issues remain of concern, even though some progress has been made. Concerns about acid rain, visibility impairment, air toxics, indoor air quality, and global climate change will be with us for years to come.

Information Contacts

The full report, "How clean is the air? Air Quality in the Tennessee Valley Region," can be obtained from the Tennessee Valley Authority, 400 W. Summit Hill Drive, Knoxville, TN 37902. It is also available at www.publicpowerinstitute.org.

For more information on this and other air quality issues, please contact:

William J. Parkhurst, 256 386-2793, wjparkhurst@tva.gov

Niki S. Nicholas, 865 632-1676, nsnicholas@tva.gov

Frances P. Weatherford, 256 386-2344, fpweatherford@tva.gov

If you would like additional information on important air quality topics, please contact Jeanie Ashe by telephone (256-386-2033), E-mail (jbashe@tva.gov), facsimile (256-386-2499), or TVA mail at CEB 2A-M, Muscle Shoals, Alabama 35662. Previous issues of On The Air may be found at <http://www.tva.com/environment/air/onthear/index.htm>.